THE NATIONAL ACADEMIES
Board on Earth Sciences and Resources

Grand Research Questions in the Solid-Earth Sciences
Final Scientific/Technical Report
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Executive Summary

Over the past three decades, Earth scientists have made great strides in understanding our planet's workings and history. Yet this progress has served principally to lay bare more fundamental questions about the Earth. Expanding knowledge is generating new questions, while innovative technologies and new partnerships with other sciences provide new paths toward answers. A National Academies committee was established to frame some of the great intellectual challenges inherent in the study of the Earth and planets. The goal was to focus on science, not implementation issues, such as facilities or recommendations aimed at specific agencies.

The committee canvassed the geological community and deliberated at length to arrive at 10 questions:

1. How did Earth and other planets form?
2. What happened during Earth's "dark age" (the first 500 million years)?
3. How did life begin?
4. How does Earth's interior work, and how does it affect the surface?
5. Why does Earth have plate tectonics and continents?
6. How are Earth processes controlled by material properties?
7. What causes climate to change—and how much can it change?
8. How has life shaped Earth—and how has Earth shaped life?
9. Can earthquakes, volcanic eruptions, and their consequences be predicted?
10. How do fluid flow and transport affect the human environment?

Written for graduate students, colleagues in sister disciplines, and program managers funding Earth and planetary science research, the report describes where the field stands, how it got there,

and where it might be headed. Our hope is that the report will spark new interest in and support for the field by showing how Earth science can contribute to a wide range of issues—including some not always associated with the solid Earth—from the formation of the solar system to climate change to the origin of life. Its reach goes beyond the United States; the report is being translated into Chinese and distributed in China.

Comparison of Proposed and Actual Accomplishments

The original goals and objectives of the project were met. The objective was to "formulate a short list of grand research questions driving progress in the solid-earth sciences. The research questions will cover a variety of spatial and temporal scales, from sub-atomic to planetary, and from the past (billions of years) to the present and beyond. The questions will be written in a clear, compelling way and will be supported by text and figures that summarize research progress to date and outline future challenges. The report will not discuss implementation issues (e.g., facilities, recommendations aimed at specific agencies) or disciplinary interests."

Summary of Project Activities

A committee of experts was appointed to carry out the study and write the report. The committee drafted a set of grand questions, which were published for comment in EOS (Linn, 2006), and also canvassed the community. More than 200 colleagues provided input or feedback. The committee met four times to choose the final questions and write the report:

January 19-20, 2006	First committee meeting, Washington, DC
March 29-30, 2006	Second committee meeting, Washington, DC
July 19-20, 2006	Third committee meeting, Washington, DC
November 29-30, 2006	Fourth committee meeting, Washington, DC

A professional science writer was engaged for a short time to ensure that the language and concepts in the report were understandable to a broad audience. The report was reviewed by 13 experts and released to the public in March 2008.

The report was released far behind schedule. Three members of the committee resigned at various stages to take on high-profile commitments, causing a meeting to be cancelled and making it necessary to obtain significant input in their subfields from the community. It also took months longer than expected to incorporate revisions from the science writer, which were in a very different style from the committee's text, and to finalize the report.

Products

Linn, A.M., 2006, Identifying grand research questions in the solid-Earth sciences, *EOS, Transactions of the American Geophysical Union*, v. 87(9), p. 98.

NRC, 2008, *Origin and Evolution of Earth: Research Questions for a Changing Planet*, National Academies Press, Washington, D.C., 137 pp., also available at http://www.nap.edu/catalog.php?record_id=12161.

A 4-page summary of the report is available at
http://dels.nas.edu/dels/rpt_briefs/origin_and_evolution_of_earth_final.pdf